Monthly Report
October 2000

Contract Number: NAS5-98076

HALOE Algorithm Improvements for Upper Tropospheric Soundings

1. Summary

General Approach

The goal of this work is to extend the HALOE retrievals into the troposphere. The approach is to begin with the current (Version 19) HALOE data, improve and correct them where necessary, combine them in a sensible fashion and retrieve the mixing ratios to lower altitudes than previously possible. The specific tasks necessary for this and current work towards their completion are detailed in Section 2.

Overview of Previous Work

New techniques for performing low altitude retrievals of CH_4, aerosol and H_2O were reformulated. This new approach consisted of using multiple channels to permit tropospheric retrievals of these species. The first step in this procedure was to implement a simultaneous CH_4 and aerosol retrieval using, respectively, the differential CH_4 signal (HCl V divided by the CH_4 V) and the CH_4 V signal. Once the CH_4 mixing ratio and the aerosol extinction have been obtained, these values will be used in other retrievals such as a NO V H_2O retrieval.

Accomplished This Month

We continued to investigate the possibility of performing a simultaneous CH_4/aerosol retrieval using the differential CH_4 signal and the CH_4 V signal. This approach proved to be unproductive due to the similarities of the transmissions of aerosol and CH_4 in the two channels; it was not possible to obtain a unique solution. We moved on to the use of the HF DV/V signal to obtain H_2O in the troposphere. We found that this technique works quite well even assuming a tropospheric CH_4 model. Comparing the results to correlative measurements proved somewhat difficult, but the results were very encouraging. We processed a 1997 latitude sweep, and that too looked quite reasonable.

Plans for Future Work

We will begin to implement a multi-channel retrieval technique to retrieve CH_4, aerosol, and H_2O in the troposphere and to produce data sets of these species that are composed of the results of all retrieval techniques and hence are continuous over the largest altitude range possible. For example, the new HF dV/V H_2O retrieval in the troposphere works very well, but may not extend up high

enough to overlap the lower portions of the H_2O channel water retrieval. An additional H_2O retrieval may be needed to bridge the altitude gap between the two retrievals.

Problems Encountered

None

2. Description of Work, Itemized by Objective

a. Pointer Tracker Error Estimates and Correction

No significant current work

b. Cloud/Aerosol Characterization and Identification

No significant current work

c. Simultaneous Multichannel Inversion Algorithm

We continued to explore the possibility of using a simultaneous differential CH_4 ($HClV/CH_4$ V) and CH_4 V retrieval to obtain CH_4 and aerosol. This proved unsuccessful because the sensitivities of the two signals to CH_4 and aerosol where such that an unique solution was not possible. While further options exist using the differential CH_4 signal, we next tried using the HF dV/V signal to obtain H_2O. It is possible to use this signal to retrieve H_2O because in the upper troposphere, the HF profile has dropped off significantly and the HF signal is quite low. Also, the dV/V signal formulation is insensitive to aerosol and, other than H_2O, the only other significant contributor to the dV/V signal, CH_4, has a well know tropospheric value of 1.7ppm.

The initial results of this new approach look very promising. Once the retrievals enter the troposphere, the H_2O signal becomes large enough to enable excellent retrievals of H_2O. We did, however, encounter some difficulties in the analyses. The first problem concerned finding correlative measurements. We were able to find only a handful of lidar and hygrometer measurements that matched up with HALOE events that were free of clouds and thus able to retrieve low enough to overlap the altitude of the correlative measurement. In addition, the variability of tropospheric H_2O requires almost an exact match in time and location between HALOE and the correlative measurement for the comparison to be of merit. The comparisons that we were able to make were very encouraging. It is also important to note that we can retrieve only on cloud free events, which means that our results will be drier than tropospheric statistics tend to indicate.

Also complicating the retrievals is the fact that the lockdown position for the 1997 sweep that was examined was not optimized for tropospheric measurements. The lockdown varied from 6 to 12 arcmins; a lockdown of 12 arcmins means that the FOV will slide off the sun before the retrievals get well into the troposphere. We will need to run other sweeps to get a better data set of tropospheric measurements.

d. Forward Model Improvements

No significant current work

e. High Resolution Gas Channel Retrievals

No significant current work

f. Improved Temperature Retrieval

No significant current work

g. Robust Error Estimates

No significant current work

h. Long Term Trend Reliability Studies

No significant current work

i. Data Validation

The consistency checks on the HALOE data continue. These include: examination of instrument/geometry dependencies such as beta angle, internal temperatures, and doppler velocity; sunrise-sunset differences; inter-comparison of Versions 18,19, and 20; and correlative measurement comparison.

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14. ABSTRACT

This report details the ongoing efforts by GATS, Inc., in conjunction with Hampton University and University of Wyoming, in NASA's Mission to Planet Earth UARS Science Investigator Program entitled "HALOE Algorithm Improvements for Upper Tropospheric Sounding." The goal of this effort is to develop and implement major inversion and processing improvements that will extend HALOE measurements further into the troposphere. In particular, 0_3, H_20, and CH_4 retrievals may be extended into the middle troposphere, and NO, HCl and possibly HF into the upper troposphere. Key areas of research being carried out to accomplish this include: pointing/tracking analysis; cloud identification and modeling; simultaneous multichannel retrieval capability; forward model improvements; high vertical-resolution gas filter channel retrievals; a refined temperature retrieval; robust error analyses; long-term trend reliability studies; and data validation. The current (first year) effort concentrates on the pointer/tracker correction algorithms, cloud filtering and validation, and multichannel retrieval development. However, these areas are all highly coupled, so progress in one area benefits from and sometimes depends on work in others.

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